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Report No. TOR-1001(2107-20)-1

ORBITING VEHICLE NONMETALLIC MATERIALS COMBUSTION AND ATMOSPHERIC CONTAMINANT CONTROL STANDARD FOR THE MOL ORBITING LABORATORY PROGRAM

Prepared by

MOL Systems Engineering Office

El Segundo Technical Operations
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El Segundo, California

Contract No. AF 04(695)-1001

September 1967

Prepared for

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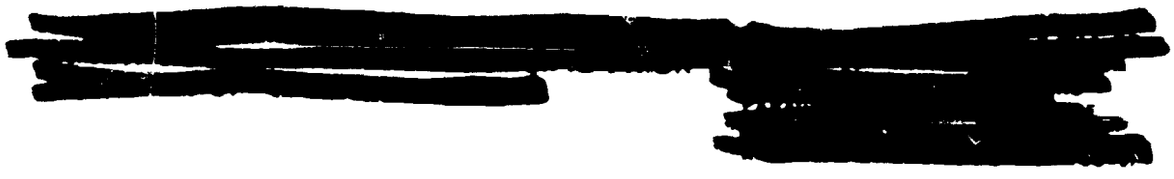

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Approved by

J. R. Henry, Director
Systems Safety Office

The information in a Technical Operating Report is developed for a particular program and is therefore not necessarily of broader technical applicability.

El Segundo Technical Operations
AEROSPACE CORPORATION
El Segundo, California

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When requirements herein conflict with those of other specifications on matters of material flammability and toxicity, the requirements delineated herein shall take precedence.

ACKNOWLEDGEMENT

This report was prepared by the MOL Systems Engineering Office. Significant contributions were made by the Air Force and the MOL contractors.

The section concerned with threshold limit values was summarized from unpublished data orginated in the 6570th Aerospace Medical Laboratory, Toxic Hazard Unit. Maximum use was made of NASA data concerned with flammability and toxicity testing.

1.0 SCOPE

This specification delineates the conditions and requirements for use of nonmetallic materials in the MOL Orbiting Vehicle with respect to the flammability and toxicity hazards. The objective is to provide a high degree of safety with due regard to practical limitations and mission objectives.

The criteria, test methods, and controls described pertain only to the flammability and toxicity hazards. Functional and other materials requirements are not included. Requirements for control of materials are delineated.

This specification does not include considerations for propellants and pyrotechnics. It should be noted that the requirements are specified in terms of the most severe environment in which the material is intended to be used. Therefore, it is necessary to control a given material for different application requirements. However, if a material satisfies the more stringent requirements, it may be applied in components with less severe requirements without further testing.

Nonmetallic materials employed, or intended for use, in or within the following components are required to satisfy the requirements set forth herein.

a. Gemini B
   1. Pressurized area
   2. Unpressurized areas
b. Tunnel Area
c. Laboratory Module
   1. Pressurized compartment
   2. Unpressurized areas (including meteoroid shield)
d. Mission Module

This specification shall be used by all contractors for procurement of materials and parts, and for the design, development, and production of the MOL Orbiting Vehicle, AGE used within the OV, and all interconnecting wiring to the OV from AGE and facilities. This specification shall control all government-furnished parts to be used in the Orbiting Vehicle.

2.0 APPLICABLE DOCUMENTS

MIL-O-27210B	Oxygen, Aviator's Breathing, Liquid Gas
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts

3.0 NONMETALLIC MATERIALS CATEGORIZATION AND CRITERIA

This section provides the criteria for selection and application of nonmetallic materials for the MOL Orbiting Vehicle with respect to flammability and outgassing as potential hazards to the success of the mission.

System constraints, general requirements, and considerations for selection and application of materials with respect to flammability and outgassing/toxicity are described.

Nonmetallic materials are categorized primarily by functional application and/or location in the MOL Orbiting Vehicle. Requirements for acceptance of nonmetallic materials are described according to the following categories.

Category A	Unrestricted-usage materials
Category B	Materials in the Gemini B pressurized area, tunnel area, and Laboratory Module pressurized compartment
Category C	Suit-loop materials
Category D	Materials in high-pressure oxygen systems
Category E	Materials in hermetically sealed containers
Category F	Materials in vented containers
Category G	Non-flight materials
Category H	Materials in unmanned areas
Category I	Electrical wiring and accessory materials

3.1 SYSTEM CONSTRAINTS*

Materials shall be qualified in the most severe oxygen environment to which they may be exposed in each application.

With respect to flammability, these environments are:

a.	Gemini B and Tunnel	
	Pressurized areas	6 psia, 100 percent oxygen
	Unpressurized areas	Air
b.	Laboratory Module	
	Pressurized compartment	6 psia, 100 percent oxygen
	Unpressurized areas	Air
c.	Mission Module	Air
d.	Suit Loop	19.0 psia, 100 percent oxygen
e.	High-Pressure Oxygen System	100 psia, 100 percent oxygen

With respect to outgassing (pertains to pressurized/manned areas only), the most severe environment is specified as 5 psia, 100 percent oxygen.

3.2 GENERAL REQUIREMENTS AND CONSIDERATIONS

With respect to flammability and outgassing, two types of tests are described: (1) materials screening tests, and (2) special tests. Screening tests are performed to eliminate unacceptable nonmetallic materials according to applicable usage categories defined herein. Special tests are required in some usage categories to evaluate the materials in their applied configurations.

---

*The criteria set forth herein are established on the basis that the crew members will be provided with individual face masks and oxygen supplies for emergency use.

**No specific requirements are delineated for the presence of particulate matter in the atmosphere; however, the contractor should be aware that this can present a hazard (atmospheric contaminant). Accordingly, during design and development, due consideration should be given to possible sources of particulate matter (e.g., the use of fibers/fabrics in areas subject to abrasion as in knees of garments, seats, corners of movable gear, etc.).

Flammability test results* at a higher pressure may be applied/used directly to qualify materials for use at lower oxygen pressure.

To qualify materials with respect to combustion rate at 6.0 psia oxygen, test results* at 5.0 psia oxygen may be used by adding a safety factor of 50 percent (i.e., combustion rate at 6.0 psia oxygen is assumed to be 1.5 times that measured at 5.0 psia oxygen).
The material shall be considered to have failed the Combustion Rate test if there is any ejection or drip of flaming particles during the test.

3.3 NONMETALLIC MATERIALS CATEGORIES AND ACCEPTANCE CRITERIA

The categories and acceptance criteria are defined in the following paragraphs. The test procedures are described in Section 4.0. When more than one sample of a given material is tested, the material shall be considered to have failed if any one sample fails the criteria.

*Provided method of measurement conforms to procedures delineated in Section 4.0.

3.3.1 Category A – Unrestricted-Usage Materials

This category describes the conditions under which a nonmetallic material may be used with no restrictions on quantity or location with regard to the flammability hazard. However, control of quantity is required with regard to the outgassing/toxicity hazard. The outer pressure-suit layer and constant wear garments shall satisfy these requirements.

a. Material Property Requirements

1. Melting (Softening) Point or Thermal Decomposition Temperature - Greater than 800°F.

2. Combustion Rate (MOL Test No. 1), Upward - Does not ignite in 6.0 psia oxygen when the ignition source is applied to the bottom of the test specimen. There shall be no ejection or drip of flaming particles during this test.

3. Carbon Monoxide Determination (MOL Test No. 2) - 5 μg/g of sample, max.

4. Total Organics Determination (MOL Test No. 2) -
   111 μg/g of sample, as methane, max,
   or 102 μg/g of sample, as propane, max,
   or 100 μg/g of sample, as pentane, max.

   For materials satisfying the criteria, if any outgassing product is present at a concentration greater than 20 μg/g of sample, it shall be identified.

5. Odor Rating (MOL Test No. 3) - 2.0 max (average score).

6. Flash and Fire Points (MOL Test No. 4) - Greater than 600°F, in 6.0 psia oxygen.

b. Exceptions

The following materials/applications shall not be used in Category A under any circumstances:

Electrical wiring and accessories, covered in Category I; suit-loop materials, covered in Category C; and materials in high-pressure systems, covered in Category D.

c. Note

Under normal operating procedures, the outer pressure-suit layer shall not be in contact with electrical wiring or bundles carrying high currents.

3.3.2 Category B - Materials in the Gemini B Pressurized Area, Tunnel Area, and Laboratory Module Pressurized Compartment

This category deals with materials used in manned (pressurized) areas that are not included in other categories. Materials in this category shall satisfy the following requirements on properties, usage restrictions, and special tests (with the exceptions noted below).

a. Materials Screening Tests

1. Combustion Rate (MOL Test No. 1), Downward - Less than 0.3 in./sec in 6 psia oxygen. There shall be no ejection or drip of flaming particles during this test.

2. Carbon Monoxide Determination (MOL Test No. 2) - 5.0 μg/g of sample, max.

3. Total Organics Determination (MOL Test No. 2) - 111 μg/g of sample, as methane, max,
or 102 μg/g of sample, as propane, max,
or 100 μg/g of sample, as pentane, max.

   For materials satisfying the criteria, if any outgassing product is present at a concentration greater than 20 μg/g of sample, it shall be identified.

4. Odor Rating (MOL Test No. 3) - 2.0 max (average score).

5. Flash and Fire Points (MOL Test No. 4) - Greater than 500°F in 6.0 psia oxygen.

b. Restrictions on Use

The specific amount and arrangement of materials in Category B shall be limited to insure the following:

1. There shall be no flame propagation to adjacent equipment due to thermal radiation or flame/mass transfer.

2. For each component or item of equipment, the pressure increase due to combustion shall not exceed 50 percent of the nominal operating pressure of the applicable compartment (pressurized area), with due allowance for pressure relief/limiting mechanisms. When possible, the contractor shall demonstrate by suitable analyses* that the above requirements are met. This analysis shall be made available to the MOL SPO on request.

*Ignition sources proximity to ignition, total combustible mass, material flammability characteristics, heat of combustion, etc., should be assessed.

In lieu of analysis, special tests (item c., below) shall be required, consistent with the following, to demonstrate that fire control criteria are satisfied in the applied configuration.

c. Special Tests

The contractor shall identify each specific test configuration, ignition source, test condition, and acceptance criteria for each test, commensurate with the following.

1. Test Configuration - The contractor may elect to test equipment/component(s) identical to that to be used in the MOL Orbiting Vehicle or to simulate the article. All potential propagation paths shall be simulated. Geometric and spatial proximity to combustible (especially nonmetallic) components shall be simulated. A complete description and rationale shall be provided to the MOL SPO.

2. Ignition Source - A standard hot-wire ignition source* or other suitable heat source shall be used. It shall be placed at the most hazardous material in the test, based on flammability, quantity present, and distribution/location. Sufficient energy shall be supplied to ignite the configuration or to assure that it will not ignite in actual service.

3. Test Conditions - All tests shall be conducted in a 6.0 psia oxygen atmosphere with an ambient temperature of 75 $\pm 5^{\circ}$F. The test set-up shall simulate or approximate the ventilation condition available to the test specimen in the flight condition. The total volume of the test chamber shall be identical to that of the applicable compartment, or scaled, as appropriate.

4. Acceptance Criteria - The pressure rise during the test shall not exceed 2.5 psi for the total free volume of the applicable compartment. There shall be no propagation of the fire to adjacent equipment. There shall be no ejection or drip of flaming particles. A motion picture record, with time hacks, shall be made.

*A nichrome wire wrapped with tissue paper is recommended. (See MOL Test No. 1.)

d. Installation Protection (For Information Only)

The following methods are among those that may be evaluated to provide non-propagating configurations of materials in Category B. The modified configuration must be subjected to the special test requirements described above.

1. Installation of non-flammable covers, panels, or other fire breaks over or between adjacent combustible materials.
2. Reduction in the quantities of Category B materials used.
3. Covering the flammable material with an inorganic coating or other appropriate fire inhibitor, aluminum foil, teflon sleeving, or non-combustible foams.

e. Exceptions

1. If materials are encompassed or enclosed within non-combustible containers, Categories E or F shall apply.
2. Electrical wiring and accessory materials are excluded from Category B (see Category I) unless used as part of the special test(s).

3.3.3 Category C - Suit-Loop Materials

This category includes all materials employed within the suit-loop that may be exposed to 19.0 psia oxygen (max), including (but not necessarily limited to) materials used in communications systems, bump hat, heart-rate monitoring systems, radiation dosimeters, helmet interior, suit bladder material, ventilation system, integral urine collection system, inner comfort liner of suit, suit compressors, carbon dioxide removal system, flexible hoses, etc. Materials in this category shall satisfy the following requirements.

a. Combustion Rate (MOL Test No. 1), Upward -

Self-extinguishing in 19.0 psia oxygen when the ignition source is applied to the bottom of the test specimen. There shall be no ejection or drip of flaming particles during this test.

b. Carbon Monoxide Determination (MOL Test No. 2)

5.0 μg/g of sample, max.

c. Total Organics Determination (MOL Test No. 2)

111 μg/g of sample, as methane, max,
or 102 μg/g of sample, as propane, max,
or 100 μg/g of sample, as pentane, max.

For materials satisfying the criteria, if any outgassing product is present at a concentration greater than 20 μg/g of sample, it shall be identified.

d. Odor Rating (MOL Test No. 3)

2.0 max (average score).

e. Flash and Fire Points (MOL Test No. 4)

Greater than 500°F in 19.0 psia oxygen.

3.3.4 Category D - Materials in High-Pressure Oxygen Systems

This category applies to materials that may be exposed to oxygen at pressures greater than 19.0 psia. Included are the pressure suit assembly (PSA) regulator and umbilical, as well as high-pressure oxygen lines, seals, filters, and valves. Such materials shall:

a. Demonstrate prior successful history of use in high-pressure oxygen systems.

b. Satisfy the following screening test requirements

1. Combustion Rate (MOL Test No. 1), Upward - Self-extinguishing in 19.0 psia oxygen when the ignition source is applied to the bottom of the test specimen. There shall be no ejection or drip of flaming particles during this test.

2. Carbon Monoxide Determination (MOL Test No. 2) - 5.0 μg/g of sample, max.

3. Total Organics Determination (MOL Test No. 2) - 111 μg/g of sample, as methane, max, or 102 μg/g of sample, as propane, max, or 100 μg/g of sample, as pentane, max.

   For materials satisfying the criteria, if any outgassing product is present at a concentration greater than 20 μg/g of sample, it shall be identified.

4. Odor Rating (MOL Test No. 3) - 0.20 max (average score).

5. Flash and Fire Points (MOL Test No 4) - Greater than 500°F in 19.0 psia oxygen.

For equipment which does not satisfy these requirements, the contractor shall submit a qualification test procedure (special test) to the MOL SPO. Upon approval thereof, the qualification tests shall be performed. Acceptability for this category will then depend on the results of these special tests.

3.3.5 Category E - Materials in Hermetically Sealed Containers

This category applies to all materials employed within hermetically sealed containers. Such containers must be sealed with no means for receiving or replenishing an oxygen supply.

For this category, materials shall be tested in the applied configuration to demonstrate that fire control criteria are satisfied (special tests). The contractor shall identify the specific test configuration, ignition sources, test conditions, and acceptance criteria for each test commensurate with the following.

Special tests of configurations representative of each generic class of hermetically sealed equipment shall be conducted to verify acceptability thereof.

a. Special Test Configuration

The contractor may elect to test equipment identical to that to be used in the MOL Orbiting Vehicle or to simulate the article. The container structure and all electrical materials shall be identical to those to be used in the flight article.

b. Ignition Source

The ignition or heat source shall be that expected in normal operation. Overload shall be applied to failure.

c. Test Conditions

For hermetically sealed containers to be used in pressurized (manned) areas, all tests shall be conducted in a 6.0 psia oxygen atmosphere with an initial container surface temperature of 115 ±5°F. However, if the container has an external configuration consisting entirely of stainless steel, aluminum, or nonmetallic materials conforming to the requirements of paragraph 3.3.1 (Category A), it may be tested in air.

Hermetically sealed containers to be used in unpressurized areas only, may also be tested in air with an initial container temperature of 155 ±5°F.

d. Acceptance Criteria

The hermetically sealed container shall not rupture as a result of this test. No flaming particles shall be emitted. No escaping gases shall be capable of igniting adjacent installed equipment.

3.3.6 Category F - Materials in Vented Containers

This category applies to materials to be used with, or as part of, unsealed (vented) containers (i.e., containers which are not hermetically sealed). Materials in this category shall satisfy the following requirements.

a. Material Property Requirements*

1.** Carbon Monoxide Determination (MOL Test No. 2) - 5.0 μg/g of sample, max.

2.** Total Organics Determination (MOL Test No. 2) - 111 μg/g of sample, as methane, max, or 102 μg/g of sample, as propane, max, or 100 μg/g of sample, as pentane, max.

For materials satisfying the criteria, if any outgassing product is present at a concentration greater than 20 μg/g of sample, it shall be identified.

3.** Odor Rating (MOL Test No. 3) - 2.0 max (average score).

4. Flash and Fire Points (MOL Test No. 4) - Greater than 500°F when tested in the applicable environment: in air for unpressurized (unmanned) areas, and in 6.0 psia oxygen for pressurized (manned) areas.

b. Special Tests

Tests of configurations representative of each generic class of vented container shall be conducted to determine acceptability thereof.

1. Test Configuration - The contractor may elect to test equipment identical to that to be used in the MOL Orbiting Vehicle or to simulate the article. The container structure and all electrical materials shall be identical to those to be used in the flight article. The configuration shall include adjacent combustible materials in the anticipated geometry and physical arrangement.

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*The Combustion Rate test (MOL Test No. 1) is suggested to insure use of materials more likely to satisfy the Special Test requirement. A downward combustion rate of less than 0.3 in./sec in 6.0 psia oxygen is recommended for materials screening purposes.

**These tests are not required if the material is to be used only in unpressurized (unmanned) areas.

2. Ignition Source - The ignition source(s) shall be representative of that to be expected in service, allowing for possible failure of components within or in proximity to the test configuration.

   For vented containers with an internal heat source, sufficient energy shall be supplied to ignite the configuration (from within) or to assure that it will not ignite under extreme overload conditions.

   For vented containers that have no internal heat source, a standard hot-wire ignition source (consisting of nichrome wire wrapped with tissue paper - see MOL Test No. 1) shall be used. It shall be placed at the most combustible material in the test configuration. Sufficient energy shall be supplied to ignite the configuration or to insure that it cannot be ignited by the ignition source under the specified test conditions.

3. Test Conditions - For vented containers to be used in pressurized areas, all tests shall be conducted in 6.0 psia oxygen atmosphere with an initial container temperature of 155 ±5°F.

   Vented containers, to be used in unpressurized areas only, may be tested in air with an initial container surface temperature of 115 ± 5°F.

4. Acceptance Criteria - The vented container shall contain an internal fire or the heat source until extinguished. No flaming particles shall be emitted. The vented gas shall not be capable of igniting adjacent installed equipment.

c. Note

Approaches which may be considered to provide acceptable configurations include filling the internal volume of the container with non-flammable material or material which prevents or impedes oxygen access, and/or reducing the quantities of combustible materials used.

3.3.7 Category G – Non-Flight Materials

This category includes those materials used in non-flight equipment during power-on tests. Such materials (with the exceptions noted below) shall satisfy the following screening test requirements.

a. Materials Screening Tests

1. Combustion Rate (MOL Test No. 1), Upward - Self-extinguishing in the applicable test environment if in the ignition source is applied to the bottom of the test specimen. There shall be no ejection or drip of flaming particles during this test.

2. Flash and Fire Points (MOL Test No. 4) - Greater than 500° F in the applicable test environment.

b. Exceptions

Electrical wiring and accessories are excluded from this category (covered in Category I).

3.3.8 Category H – Materials in Unmanned Areas

This category applies to materials used in unmanned (unpressurized) areas of the MOL Orbiting Vehicle. Such materials (with the exceptions noted below) shall satisfy the following screening test requirements.

a. Materials Screening Tests

1. Combustion Rate (MOL Test No. 1), Upward - Self-extinguishing in air when the ignition source is applied to the bottom of the test specimen. There shall be no ejection, drip, of flaming particles during this test.
2. Flash and Fire Points (MOL Test No. 4) - Greater than 500°F in air.

b. Exceptions

Self-combustible materials (e.g., pyrotechnics) and propellants are not included in this specification.

Electrical wiring and accessories are excluded from this category (covered in Category I).

3.3.9 Category I – Electrical Wiring and Accessory Materials

This category includes: electrical wiring with its insulation and all accessory electrical materials (electrical connectors, grommets, shells, mounts, pottings, conformal and other coatings, terminal boards, harness ties, supports, fillers, identification tags, shrink-fit tubing, sleeving, etc.) used in the MOL Orbiting Vehicle; all carry-on electrical equipment; and all interconnecting wiring to the MOL Orbiting Vehicle from aerospace ground equipment (AGE) and facilities.

a. Requirements

1. Combustion Rate (MOL Test No. 1), Upward - Self-extinguishing in the designated test environment (noted below) when the ignition source is applied to the bottom of the test specimen.

   (a) For unmanned (unpressurized) areas - air

   (b) For manned (pressurized) areas - 6.0 psia oxygen

   (c) For suit loop and high-pressure oxygen system - 19.0 psia oxygen

   There shall be no ejection or drip of flaming particles during this test.

2.* Carbon Monoxide Determination (MOL Test No. 2) - 5.0 μg/g of sample, max.

3.* Total Organics Determination (MOL Test No. 2) - 111 μg/g of sample, as methane, max, or 102 μg/g of sample, as propane, max, or 100 μg/g of sample, as pentane, max.

   For materials satisfying the criteria, if any outgassing product is present at a concentration greater than 20 μg/g of sample, it shall be identified.

4.* Odor Rating (MOL Test No. 3) - 2.0 max (average score).

5. Electrical Wire Insulation and Accessory Flammability Test (MOL Test No. 5) - The criteria for acceptance for electrical wire insulation and electrical wire accessories shall be as follows.

*These tests are not required if the material is to be used only in unpressurized (unmanned) areas.

(a) For electrical wire insulation:

(1) The electrical wire insulation shall not sustain combustion for a period of more than 2 sec in the designated test environment (as noted in paragraph 3.3.9.a.1, above) following removal of the ignition source with current overloads up to the melting point (fusion) of the metal conductor.

(2) The electrical wire insulation shall be considered to have failed this test if more than 50 percent of the insulation on the test bundle is consumed prior to self-extinction of the flame, including any burning prior to melting of the metal conductor.

(b) For electrical wire accessory materials:

(1) The accessory shall not sustain combustion for a period of more than 2 sec in the designated test atmosphere (as noted in paragraph 3.3.9.a.1, above) following removal of the ignition source with current overloads up to the melting point (fusion) of the metal conductor.

(2) There shall be no ejection or drip of flaming particles from the accessory material.

6. Electrical Connector, Potting Compounds, and Coatings Flammability Test (MOL Test No. 6) -

(a) The connector and its components/potting compound/coating shall not sustain combustion for a period of more than 2 sec in the designated test environment (as noted in paragraph 3.3.9.a.1, above) following removal of the ignition source with current overloads up to the melting point (fusion) of the metal conductor or connector contact(s).

(b) The connector and its components/potting compound/coating shall be considered to have failed this test if more than 50 percent of the material is consumed prior to self-extinction of the flame, including any burning prior to melting of the metal conductor or conductor contact(s).

(c) There shall be no ejection or drip of flaming particles.

(d) The material shall be considered to have failed if any one test sample fails to satisfy these criteria.

7. Electrical Harness Assembly Overload Test (MOL Test No. 7) - There shall be no ignition when tested in the designated test environment (as noted in paragraph 3.3.9.a.1, above) in accordance with the procedures described in MOL Test No. 7.

b. Exceptions

Electrical wiring and accessory materials used inside hermetically sealed and vented containers are excluded from this category (covered in Categories E and F).

3.4 MOL THRESHOLD LIMIT VALUES FOR ATMOSPHERIC CONTAMINANTS

MOL Threshold Limit Values (MOL TLV) are presented in Table 3-1 for potential toxic components of the atmosphere in manned areas. The chemical compounds included in Table 3-1 represent contaminants which are generally characterized as volatile, low-molecular-weight chemicals with known toxicological properties that have been identified in the closed system atmospheres of nuclear submarines or space cabins. This list shall be expanded as specific trace contaminants are identified in the pressurized (manned) areas. In addition, if any outgassing product identified during the materials tests (Total Organics Determination, MOL Test No. 2) required in paragraph 3.3, is not listed in Tables 3-1 and 3.2, a determination shall be made of its Threshold Limits. This information shall be provided to the MOL SPO for possible addition to Tables 3-1 and 3-2.

The definition of the contaminant environment in the MOL pressurized areas as summarized in Table 3-1 is limited to the assignment of a MOL TLV for an individual contaminant. However, the toxicity problems inherent in the final vehicle must consider the simultaneous effects of all contaminants. When multiple toxic contaminants are present in a closed system, the combined acute toxicity effects of all contaminants must be given primary consideration. The effects of multiple contaminants may be additive, potentiating, or independent. These variable effects should be considered by identifying the primary target organ for the individual compounds. The resulting chemical mixtures that exert additive or potentiating acute toxicity effects on a specific target organ should be assigned new MOL TLVs. If the primary effect of a contaminant is independent, then the individual MOL TLVs shall be valid.

Two classes of non-toxic chemicals that must be recognized as potential contaminants are covered in Table 3-2. These include explosive gases and simple asphyxiant gases. The simple asphyxiant gases represent the primary component and contaminants of the diluent gas fraction of a two-gas system.

Table 3-1. MOL Threshold Limit Values (MOL TLVs)

Chemical Name	Chemical Formula	Molecular Weight	Boiling Point (°F) (760 mmHg)	MOL TLV (milligrams/m^3)
Acetaldehyde	$CH_3 - C \overset{O}{=} H$	44.1	69.8	50
Acetone	$CH_3 - \overset{O}{\overset{\|}{C}} - CH_3$	58.1	133.9	200
Ammonia	NH_3	17.0	-28.1	20*
Carbon Dioxide	CO_2	44.0	-109.1	12,000**
Carbon Monoxide	CO	28.0	-310	29*
Chlorine	Cl_2	70.9	-30.2	1.6
Dimethyl Sulfide	$(CH_3)_2$-S	62.1	99.5	3†
Formaldehyde	$H - C \overset{O}{=} H$	30.0	-5.8	1.0
Fluorine	F_2	38.0	-304	0.02
Hydrogen Chloride	HCl	36.5	-118	0.15*
Hydrogen Cyanide	HCN	27.0	78.8	2.2
Hydrogen Fluoride	HF	20.0	67	0.06*
Hydrogen Sulfide	H_2S	34.1	-79.2	2.0
Mercury	Hg	200.6	674	0.004
Methyl Mercaptan	CH_3SH	48.1	45.7	3†

Table 3-1. MOL Threshold Limit Values (MOL TVLs) (Continued)

Chemical Name	Chemical Formula	Molecular Weight	Boiling Point (^{o}F) (760 mmHg)	MOL TLV (milligrams/m^3)
Nitric Oxide	NO	30.0	-241.2	5.0††
Nitrogen Dioxide	NO_2 (or N_2O_4)	46.0	70.2	5.0
Ozone	O_3	48.0	-169.4	0.10
Pentane	$CH_3(CH_2)_3-CH_3$	72.2	97	300
Phosgene	$Cl_2 - C = 0$	98.9	47	0.40*
Sulfur Dioxide	SO_2	64.1	14	3.0
Toluene	$C_6H_5CH_3$	92.1	230.7	75.

* Represents nuclear submarine 90-day continuous exposure level
** MOL EC/LS design requirement
† Based on hydrogen sulfide
†† Based on nitrogen dioxide

Table 3-2. MOL Explosive Limits and Asphyxiant Gases

Explosive Gases		Simple Asphyxiant Gases
Compound	Explosion Limit (mg/m^3)	
Hydrogen	1,110	Helium
Methane	11,300	Argon
		Nitrogen

The contractor for the Laboratory Module shall demonstrate by ground testing (LMQTV) that the system will measure and maintain atmospheric contaminants in the atmosphere of the pressurized compartment at levels below those listed in Tables 3-1 and 3-2.

For the Gemini B, the contractor shall demonstrate that the atmospheric contaminants produced in the pressurized area will not exceed the limits listed in Tables 3-1 and 3-2.

4.0 MATERIAL TESTS AND PROCEDURES

4.1 INTRODUCTION

This section presents the standard test requirements and procedures. The adoption of these procedures does not necessarily nullify the work nor the results of tests that have been performed according to other specifications. In such cases, the results of those tests shall be evaluated by the contractor in relation to the criteria and requirements of this specification, and submitted to the MOL SPO for review, evaluation, and approval.

The detailed procedures delineated herein may be replaced by alternate procedures when it has been demonstrated that these procedures will provide the same results at the same test conditions.

The tests have not been standardized. As standardization is achieved, minor modifications to the procedures will be required to improve precision and to obtain uniform test results from sources providing test data.

The recommended order of testing is:

a. Combustion rate
b. Carbon monoxide and total organics
c. Odor
d. Flash and fire points

This section defines the test conditions for all materials which are to be used in the MOL Orbiting Vehicle. If a material is to be used in an environment which would impose more stringent conditions, that material shall be tested to the higher level requirement before it is considered acceptable for the specific application.

4.2 COMBUSTION RATE OF MATERIALS (MOL TEST NO. 1)

4.2.1 Purpose

This procedure is designed to eliminate from the Orbiting Vehicle those undesirable materials which would enable a fire to spread before it can be brought under control.

4.2.2 Test Equipment

4.2.2.1 Test Chamber

The test chamber shall have a minimum volume of 3 cu ft. It shall be suitably constructed and protected to insure safe operation. A window or viewing port for visual observations and/or photographic coverage shall be included. The test chamber shall contain inlets for vacuum, an ignition wire, air, and oxygen. A vertical sample holder shall be included and positioned within the test chamber.

4.2.2.2 Pressure Gauge

The pressure gauge shall be capable of measuring pressures from 1 to 1000 ±5 Torr.

4.2.2.3 Oxygen Supply (When Used)

Commercially available oxygen, with an analytical oxygen content of 95 percent or greater, conforming to specification MIL-O-27210, Type 1, shall be used. Suitable equipment for transferring oxygen to the test chamber shall be provided.

4.2.2.4 Sample Holder

The sample holder shall consist of a vertical mounted metal clamp which will overlap 1/4 in. on each side of a specimen along the full length of the sample, leaving a 2-in. wide by 5-in. long exposed center section.

4.2.2.5 Ignition Source

The sample shall be ignited by employing a regulated-energy flux. The ignition source shall be a heated nichrome wire wrapped with a 1 x 2 in. piece of facial-type tissue paper and placed in contact with the top or bottom (as required) edge of the sample. The power supply to the wire shall consist of sufficient power, controlled by means of a variable transformer, to ignite the specimen.

4.2.2.5.1 Ignition Source Placement

If severe shrinkage occurs during test, the sample should be either wrapped around or continually compressed by suitable means to the ignition source. The placement of the sample on, around, and in contact with the ignition source shall be achieved in such a manner as to preserve maximum exposed surface(s) for oxygen access at the point(s) of ignition.

4.2.3 Sample Preparation

All material specimens shall be free of cuts, abrasions, or other flaws as determined by close visual inspection. Before test, specimens shall be cleaned by light cleaning methods appropriate to the material under test. A procedure shall be used that leaves no residue upon drying and does not alter the sample. When the sample is an electrical wire, twisted pair of wires, or any specimen material which shall be tested in conjunction with, attached to, or in intimate contact with an electrical wire, it shall be subjected to a Dielectric Withstanding Voltage test in accordance with MIL-STD-202, Method 301, at 1500 volts ac or dc minimum, to verify electrical integrity of the sample prior to testing.

Films and fabric shall be tested in their "as purchased" condition. These shall be cut out in the form of rectangles 2-1/2 in. wide and 5-in. long. Foams or other thick materials shall be used in 1/2 in. thickness or the applied thickness ("as used" density), whichever is thinner. Woven fabric shall be tested parallel to warp and parallel to fill.

Primers, coating materials, and paints shall be applied on a standard aluminum substrate material. The coatings shall be applied in a thickness equivalent to normal practice of use and post-cured in accordance with prescribed manufacturing specification (to be identified with sample).

Materials and components which will be used in irregular size or shape shall be tested in the "as purchased" configuration. They shall be attached to the sample holder by fiberglas threads or by some other suitable technique.

4.2.4 Test Procedure

The procedure shall be conducted in the following sequence:

a. The sample materials shall be prepared according to the procedure described in paragraph 4.2.3.

b. The sample shall be mounted in the vertical sample holder and positioned within the test chamber. The ignition wire shall be placed in contact with the top or bottom of the sample, as required (see paragraphs 4.2.2.5 and 4.2.2.5.1).

c. When oxygen is used, the test chamber shall be evacuated to a pressure of 1 to 5 Torr. Allow the chamber to stand for one minute. A leak is indicated if an increase in test chamber pressure is observed. The system shall be brought to atmospheric pressure and the leak corrected before any additional tests are performed. Repeat the leak check. Then repressurize to desired pressure with the required atmosphere.

d. After the test chamber has stabilized at the desired pressure, soak the specimens 10 min for dense materials and 30 min for porous materials. Apply current to the wire. When ignition of the sample is observed, determine the rate of flame-front propagation by a suitable technique. Observe the flame for any ejection or drip of flaming particles; record whether or not this is observed. Record the nature of the flame, coloration, soot, residue, and any other pertinent observations.

e. **Three samples of each material shall be tested. Materials exhibiting a combustion rate greater than specified for their category shall be rejected.**

4.2.5 Report

The following test data and pertinent information concerning the materials tested shall be reported.

a. Name of the material (generic).

b. Vendor designation and vendor.

c. All applicable material and process specifications and sample preparation details.

d. Dimensions, including thickness and weight, of each sample.

e. Usage, quantity, dimensions, and surface area to be used in the Orbiting Vehicle.

f. Combustion rate in inches per second for each sample.

g. Combustion characteristics (for example, smoke and degradation) for each sample.

h. Test environment (atmosphere and pressure).

i. Disposition or status, dimension, and size of residual sample material.

j. Note any deviations from test procedure.

k. Name and number of test procedure.

l. Date of test.

m. Test number or log number

n. Identify of testing agency or component.

o. Name of test coordinator.

4.3 DETERMINATION OF ORGANIC OFFGASSING PRODUCTS AND CARBON MONOXIDE (MOL TEST NO. 2)

4.3.1 Purpose

This procedure establishes the criteria for determining the suitability of non-metallic materials for use in the manned areas of the Orbiting Vehicle, with respect to production of potentially toxic or objectionable materials by outgassing.

4.3.2 Test Equipment

4.3.2.1 Test Chamber

The test container shall have a minimum main container volume of two liters. It shall have a configuration and be fabricated of materials which allow ready cleaning. The container and gas handling system shall be proven to give off negligible gaseous products under the test conditions by running blank or control tests. The container shall be connected to a series of traps and inlet tubes to permit evacuation, pressure readings, oxygen introduction, and sample withdrawal for determination of volatile outgassing components. An alternate method may be to connect the container directly to a gas chromatograph and/or mass spectrometer for the gas analyses.

4.3.2.2 Heating Source

The oven shall maintain constant temperature control over the test container at 155 $\pm 5^{\circ}F$. The temperature during sample exposures shall be recorded.

4.3.2.3 Vacuum Pump

The vacuum pump shall be capable of producing a vacuum less than 1 Torr and no significant system contaminants.

4.3.2.4 Analytical Equipment

The analytical equipment shall consist of the following, and of any other instruments which the test operator desires to use to completely and efficiently evaluate outgassing products. These equipment items shall be identified.

a. Gas chromatograph system/recorder, thermal conductivity, and hydrogen flame ionization detectors. The columns shall have the capability of separating light organic and inorganic gases; organic sulfides and mercaptans, halogenated hydrocarbons, representative aliphatic and aromatic hydrocarbons including aldehydes, ketones, alcohols, and esters. (The hydrogen flame ionization detector has greater sensitivity to organic materials. Conversely, because of the flame ionization detector's lack of sensitivity to the other compounds listed above, the thermal conductivity detector is used for their detection.)

b. Recording infrared spectrophotometer with accessories capable of analyzing (1) liquids (3 μl or less), or (2) gases (using a gas cell of suitable path length).

c. Mass spectrometer.

d. Trapping system suitable for trapping and transfer of microliter quantities of liquid from the gas chromatograph to the infrared spectrophotometer or mass spectrometer. A direct gas chromatograph-mass spectrometer connection can replace the trapping system if desired.

e. Gas sampling system suitable for transfer of measured volumes of gas samples from the test chamber to the gas chromatograph.

f. Calibration gas samples as required to quantify detector sensitivity and readout. (These may be bought from a manufacturer or made up in the laboratory.)

4.3.3 Test Specimens

a. All samples shall be weighed prior to and after exposure; the percentage weight change shall be determined to an accuracy of ±0.1 percent. To the extent practical, specimens shall weigh 5.00 ±0.25 g/liter of test container volume and shall be weighed to the nearest 0.1 mg prior to the test.

b. Coatings, finishes, primers, adhesives, solid-film lubricants, etc., shall be applied to a chemically cleaned aluminum substrate of suitable thickness and in a coating thickness equal to production practice. The aluminum surface shall be approximately 300 sq cm/liter of test container volume and may be coated on one or both sides.

c. Films, fabrics, plastics, etc., other than foams shall be exposed when possible with an area of 16 sq in. and approximately 1/32-in. thick or per weight unit (5 g/liter).

d. Foams shall be tested in their "as used" density. Five g/liter of free test volume shall be used unless the volume of the foam would exceed one third of the volume of the test container.

e. Electrical insulation specimens, where possible, shall be in 4-in. lengths or quantity equivalent to an exposed surface area of 16 sq. in.

f. Specimens shall be brush-cleaned.

g. Fluids, greases, and non-conformable materials shall be placed in chemically cleaned, tared, aluminum containers for analysis.

h. The samples shall be in the cured state or in the physical state specified for use. Materials tested after application or cutting to test configuration shall be aged at least one week but not over one month before testing, when possible. The temperature during aging shall be maintained at 60° to 85°F in an environment free from corrosive or solvent fumes.

4.3.4 Preparation of Test Equipment

Prior to analysis, all glassware must be clean. (A suggested procedure is to wash the glassware in a hot detergent solution, rinse in distilled water, and dry at approximately 400°F for 30 min.) Periodically, a completely clean system shall be checked for contamination by withdrawal of a sample for analysis by gas chromatography.

The test system shall be free of leaks. Checks for leaks shall be made before each test.

4.3.5 Procedure

a. The test container shall be purged with high-purity oxygen (zero hydrocarbons) until the minimum oxygen concentration is 95 percent at 260 ±5 Torr. The container shall then be heated to 155° ±5°F.

b. After 24 hr, the oxygen shall be checked for contaminants with the gas chromatograph. Proceed if the total contamination is less than 10 ppm by volume. If the contamination exceeds the above values, the test container shall be flushed and rechecked after an additional 24 hr. This procedure shall be continued until the contamination is below the specific level of 10 ppm. If the gassing contamination continues indefinitely, modification of the test container shall be necessary.

c. A clean, weighed specimen, prepared in accordance with paragraph 4.3.3, shall be placed in the test container.

1. The container shall be evacuated through a liquid nitrogen trap to below 1 Torr. The container shall then be pressurized with oxygen filtered through a 5 X molecular sieve bled into the chamber.* The container shall then be placed on an oven pre-heated to 155 ±5°F. The conditions of exposure shall be 260 ±5 Torr of 95 percent pure oxygen minimum and 155° ±5°F for a period of 72 hr. Following the designated exposure period, the container shall be brought to room temperature. The pressure in the test container shall be measured and recorded; the container shall be pressurized to one atmosphere with pure oxygen.** The test specimen shall be removed from the container and weighed after gas samples are taken.

2. A gas sample shall be taken from the reaction flask by directly fixing a gas sampling bottle on an inlet tube and evacuating through a liquid nitrogen trap to below 1 Torr. The sampling bottle shall be closed off to the vacuum; the reaction container

*If a metal container is used, filling may be accomplished by pressurizing to 30 psia and evacuating to 260 Torr three times.

**Gas samples may be taken at the final pressure prior to pressurizing to one atmosphere, if desired.

shall be opened and a gas sample permitted to flow into the bottle. An alternative method may be to connect the test container to an evacuated sampling loop on the analytical apparatus. The sample shall be analyzed for the following components:

(a) Total organics and carbon monoxide.

(b) Determination of individual outgassing components above 20 μg/g of sample weight.

3. Total organics shall be determined by use of the gas chromatograph with the pertinent columns. Beckman Total Hydrocarbon Analyzer, or an equivalent instrument. The results shall be reported as μg of total organics as methane (or other standard hydrocarbon) per gram of sample.

4. The carbon monoxide concentration shall be determined utilizing appropriate separation and analytical techniques.

5. A partitioning column and flame ionization detector may be used to determine whether individual organic constituents exceed 20 μg/g sample. Further identification will require either standard gas samples for comparison with the gas chromatograph peaks, the use of a mass spectrometer, or other analytical techniques capable of identifying constituents.

6. If there is evidence of condensation of outgassed products, the residue shall be examined by appropriate analytical techniques to determine the quantity and identity of the constituents.

4.3.6 Reporting Data

The following test data and pertinent information concerning materials tested shall be reported:

a. Name of the material (generic).

b. Vendor designation and vendor.

c. All applicable material and process specifications, and sample preparation details.

d. Sample dimensions and weight.

e. Usage, quantity, dimensions, and surface area in the Orbiting Vehicle.

f. Results of tests:

1. Total organics, μg/g in terms of methane or other standard.
2. Identity of organics greater than 20 μg/g.
3. Carbon monoxide μg/g.
4. Weight loss
5. Amount and type of any condensate.

g. Disposition or status, dimensions, and size of residual sample material.

h. Note any deviations from test procedure.

i. Name and number of test procedure.

j. Date of test.

k. Test number or log number.

l. Identity of the testing agency or component.

m. Name of test coordinator.

4.4 ODOR TEST (MOL TEST NO. 3)

4.4.1 Purpose

These procedures are designed to eliminate materials unsuitable for use in the manned areas. A material that fails this specification shall not be used.

4.4.2 Odor Criteria

4.4.2.1 Selection of Test Panel for Odor Evaluation

The test conductor shall establish a pool of qualified personnel. Members of the pool shall be male non-smokers and each member shall be capable of detecting seven basic odors from the following solutions:

Primary Odor	Standard Compound	Amount Dilution in Water
Ethereal	1, 2 - dichloroethane	0.4 ml in 500 ml
Camphoraceous	1, 8 - cineole	5 µl in 500 ml
Musky	15 - hydroxypentadecanoic acid lactone	1 mg in 1,000 ml
Floral	1-methyl-1-ethyl-2-phenyl propanol-1	0.075 ml in 500 ml
Minty	menthone (dl)	2 µl in 333 ml
Pungent	formic acid	25 ml of 90 percent solution in 500 ml
Putrid	methyl disulphide (methyl dithiomethane)	1 µl in 10,000 ml

a. Members of the pool shall be given three odorless solutions along with the seven primary odor standards for the detection of odor.

b. The solutions shall be freshly prepared at least once a month or sooner as needed.

c. The established pool for odor evaluation shall be requalified every three months or less.

d. A panel of five or more members shall be selected from the pool for odor evaluations.

e. Members of the pool shall not participate on the panel if their sense of smell is affected in any manner.

f. One of the seven basic odors shall be presented to the panel members as a standard for sensing odor prior to evaluation of odors from any sample material.

g. Panel members shall not be permitted to see or know the sample material being evaluated for odor.

h. Odor evaluations on sample materials shall be performed in an odor-free room.

i. Odor evaluations shall be performed on every new bottle of oxygen used for the tests.

4.4.2.2 Odor Evaluation

Each panel member shall evaluate the odor of a sample according to the following scale:

Member's Rating	Test Conductor's Rating
Undetectable	0
Barely Detectable	1
Easily Detectable	2
Objectionable	3
Irritating	4

4.4.3 Carbon Monoxide Determination

To avoid undue exposure of panel members to high carbon monoxide concentrations, the carbon monoxide content of the chamber shall be tested by the Kitagawa* method, or other qualified procedure, before conduct of the odor test.

*Kitagawa, T., Proc. Intern. Congr. Occupational Health 13th, New York, 1960, page 506.

4.4.4 Test Equipment

a. Test Chamber

The test chamber shall be made of pyrex glass. Internal volume shall be two liters minimum. The test chamber shall have the following component parts:

1. A gas-tight removable cover.
2. A sampling valve.
3. A sampling port capable of being sealed with a septum.

A laboratory vacuum desiccator may be utilized as part of a test chamber.

b. Oven

The oven shall be capable of providing a constant temperature of 155 ±5°F.

c. Oxygen Supply

The oxygen shall conform to MIL-0-27210, Type 1. Suitable equipment for transferring oxygen to the test chamber shall be used.

d. Sample Transfer Equipment

Syringes shall be used for measuring and transferring the sample atmospheres from the test chambers to panel members face mask.

e. Pressure Gauge

The pressure gauge shall be capable of measuring pressures from 1 to 760 ±1 Torr.

f. Olfactometer

The olfactometer shall consist of a mask made of odorless flexible material which can be applied to a panel member's face.

g. Odor-Testing Equipment

All odor-testing equipment shall be non-producers of odor and carbon monoxide, under test conditions set forth under paragraph 4.4.6.

4.4.5 Sample Preparation

a. Sample materials that have a defined volume or shape shall be cut into strips 1/8-in. thick or less with sufficient length and width to provide a 5.00 ±0.25 gm sample per liter of test chamber volume.

b. Film and fabric materials shall be tested in their "as purchased" condition, with sufficient area to provide a 5.00 ±0.25 gm sample per liter of test chamber volume.

c. Primers, coatings, and adhesives shall be applied to chemically clean aluminum substrate panels of suitable thickness. The materials shall be applied in a thickness equivalent to normal practice of use, and shall be post-cured according to manufacturing practice. The total coated panel area to be tested shall be 300 square centimeters per liter of test chamber volume. The panels may be cut into smaller pieces for convenience of exposure in the test chamber. The panels may be coated on both sides.

d. Liquids such as greases, lubricants, oils, coolants, etc., shall be contained as samples in aluminum weighing dishes approximately 2 in. in diameter. The liquid test samples shall weigh 5.00 ±0.25 gm per weighing dish and per liter of test chamber volume.

4.4.6 Test Conditions

a. The atmosphere in the test chamber at the start of the test exposure shall be MIL-O-27210, Type 1, oxygen at 260 ±5 Torr.

b. The sample materials shall be heated at a temperature of 155 ±5°F for a test duration of at least 72 hr.

c. For a leak test, the test system shall not increase in pressure more than 1 Torr while remaining at a reduced pressure of 1 Torr for a time period of 1 hr.

d. Each sample material shall be tested in a separate test chamber.

e. All odor evaluations and carbon monoxide measurements shall be carried out within 3 hr of the conclusion of the thermal treatment.

f. All measuring equipment shall have the proper calibration stickers.

4.4.7 Test Procedure

The procedure shall be conducted in the following order:

a. Sample materials shall be prepared according to the conditions outlined under sample preparation in paragraph 4.4.5.

b. After placing sample materials in separate test chambers, the test chamber shall be evacuated to one Torr or less. The test chambers shall then be pressurized to 260 ±5 Torr with MIL-0-27210, Type 1, oxygen.

c. The test chambers shall be exposed to a temperature of 155 ±5°F in an oven for a time period of at least 72 hr, allowing time for initial warm-up.

d. Following the isothermal exposure, the test chambers shall be removed from the oven and allowed to return to room temperature.

e. The pressure in the test chambers shall be measured and recorded.

f. Observation of distillable residues on interior chamber walls shall be made and recorded. A material that deposits a residue on the chamber walls may be rejected.

g. The test chambers shall be pressurized to one atmosphere with oxygen and a sampling septum installed.

h. A sample shall be withdrawn and the carbon monoxide content determined by the Kitagawa method or other qualified procedure. A content in excess of 25 ppm shall preclude odor testing at this time. The odor test shall be resumed if subsequent samples evolve less than 25 ppm of carbon monoxide.

i. *Known volumes of sample atmosphere shall be extracted from the test chambers by means of a syringe and diluted with fresh oxygen in the following proportions:

   1. One part of sample atmosphere to 29 parts of oxygen.
   2. One part sample atmosphere to nine parts of oxygen.
   3. No dilution.

*A material that fails the criteria for any category at any dilution described in paragraph 4.4.7 i. shall be unequivocally rejected for usage in manned areas of the Orbiting Vehicle.

4.4.8 Reporting Data

The following test data and pertinent information concerning materials tested shall be reported.

a. Name of material (generic).

b. Vendor designation and vendor.

c. All applicable material and process specifications, and sample preparation details.

d. Sample dimensions and weight.

e. Usage, quantity, dimensions, and surface areas to be used in Orbiting Vehicle.

f. Carbon monoxide content and method of determination.

g. Individual and average rating numbers determined by panel members.

h. Definition of odor as interpreted by each panel member.

i. Note of any deviations from test procedure.

j. Name and number of test procedure.

k. Date of test.

l. Test number or log number.

m. Identity of testing agency or component.

n. Name of test coordinator.

4.5 FLASH POINT AND FIRE POINT DETERMINATIONS (MOL TEST NO. 4)

4.5.1 Purpose

This test is designed to determine the flammability characteristics of non-metallic materials which are to be used in the manned areas.

4.5.2 Definitions

a. Flash Point

The flash point is the lowest temperature at which a material will give off, at or near its surface, flammable vapor which, when mixed with oxygen or air in the environment and exposed to an ignition source, will provide a non-self-sustaining flash or flame.

b. Fire Point

The fire point is the lowest temperature at which the mixture of vapors from the surface of a material and air or oxygen continue to burn after ignition. A self-sustaining, self-propagating glow, evidence of charring, self-sustaining combustion, or other signs of pyrolysis, shall be considered equivalent to flaming combustion.

4.5.3 Test Equipment

4.5.3.1 Test Chamber

a. Construction

The test chamber shall be constructed to insure safe operation. A window or viewing port for visual observations shall be included. The chamber shall be fully protected against the possibility of operator injury in the event of explosive rupture.

No highly volatile organic materials used in the construction shall be exposed to the interior atmosphere of the test chamber.

The chamber volume shall provide a minimum of 1 liter/5g of test sample and be equipped with a pressure gauge capable of measuring pressures from 1 to 1000 ±5 Torr.

The test chamber may be heated by any suitable method. However, the heating method must permit a temperature rise capability of at least 25°F per minute at 200°F and must maintain a temperature over the test chamber uniform within ±10°F after a one-minute hold at 600°F.

b. Thermocouple

All temperature measurements made in the interior atmosphere of the test chamber shall be made using suitable thermocouples. Temperatures shall be measured at one point on the test face of the specimen and at any other location if desired for information purposes.

c. Spark Ignition Equipment

Spark needles shall be of platinum, platinum-rhodium alloy, platinum-iridium alloy wire or stainless steel, shaped to a 0.004-in. radius point. The spark gap shall be adjusted to an electrode gap of 1/8-in. at the beginning of each test.

Spark energy shall be supplied by a high voltage capacitor. The capacitor shall be charged with a high-voltage power supply to a sufficient voltage to break down the dielectric gap between the electrodes. The sparking circuit shall be of minimum convenient capacitance, inductance, and resistance.

d. Gas (Oxygen and Air) System

The gas used shall be brought into the chamber and exhausted directly from the chamber in any safe manner consistent with smooth, gentle gas flow around the specimen. The gas system shall be equipped with suitable flow and pressure monitoring and control devices to meet the test procedure requirements.

e. Temperature Monitoring

Thermocouple readings may be monitored by multiple point recorders or any equally accurate method.

f. Flash and Fire Points

The flash and fire points shall be observed visually in a darkened room or with the aid of a photocell.

4.5.4 Test Sample Preparation

a. Bulk materials shall be in the form of rectangular sheet stock 1×4×0.03 in., unless otherwise specified.

b. Coatings, finishes, primers, adhesives, solid film lubricants, etc., shall be applied to one side of a chemically cleaned unclad aluminum substrate 1 × 6 × 0.020 in., in a coating thickness equal to production practice. Pretreatment of aluminum and coating application technique shall conform to established practice for the material being tested.

c. Film and fabric material shall be tested in their "as purchased" thickness with length and width dimensions of 4-in. and 1-in. respectively.

d. Foams shall be in the form of rectangles, 1 × 5 × 0.5 in. and in their "as used" density.

e. Electrical wire insulation specimens shall be in the form of insulated wire, 6 in. long. The insulation shall extend the full length of the wire.

f. Materials not suited to testing in the forms described above shall be tested in special forms. The test specimen weight shall not exceed 5 g/liter of chamber volume, and the specimen configuration shall be recorded.

g. The specimens shall be cleaned and dried, leaving no residue that will alter the flash and fire point.

4.5.5 Test Procedure

a. The test specimens shall be conditioned by exposure to the appropriate atmosphere and pressure for at least 10 min for dense materials and 30 min for porous materials at room temperature.

b. The test chamber shall be thoroughly cleaned before each test.

c. The specimen shall be mounted in the test chamber with its longest dimension vertical. The sparking point of the ignition needles shall be 0.031 ±0.005 in. from the surface at the top of the specimen.

d. When oxygen is used, the test chamber shall be closed and evacuated, then filled with oxygen, 95 percent purity conforming to MIL-O-27210, Type 1. Evacuating and filling shall be continued until a calculated 99.4 percent or higher oxygen concentration of the purity noted above exists in the system. The system shall be leak-tested.

e. At the conclusion of the leak test, chamber heating power sufficient to cause the internal gas temperature to rise at the rate of 25° ±2°F per min. shall be applied. The charged capacitor shall be discharged through the sparking needles once each 15 sec. The heating and spark application shall continue until the flash point is determined.

f. Observation of any indication of flash of vapors or sample shall be recorded.

g. The fire point tests shall be a continuation of the flash point test. The temperature at which there is sustained burning (fire point) shall be recorded. Where flash does not preceed fire, the flash point determination shall be considered void.

h. Testing of flash and fire points shall be stopped when the maximum temperature of 600°F has been reached.

i. The test shall be discontinued if the behavior of the enclosed volume around the spark indicates, by repeated strong flashes of igniting gases, that dangerous quantities of potentially explosive gases are being evolved.

j. Three samples of each material shall be tested.

4.5.6 Reporting Data

The following test data and pertinent information concerning materials tested shall be reported.

a. The temperature at which vapors ignite with a non-self-sustaining flame and no evidence of pyrolysis of the surface of the material shall be recorded as the flash point.

b. The temperature at which self-sustaining, self-propagating flame or glow is apparent on the surface of the material shall be recorded as the fire point.

1. Name of the material (generic).

2. Vendor designation and vendor.

3. All applicable material and process specifications, and sample preparation details.

4. usage, quantity, dimensions, and surface area in the Orbiting Vehicle.

5. Flash and fire points, combustion characteristics, and pyrolysis temperature if possible for each sample.
6. Test environment (atmosphere and pressure).
7. Dimensions, size and weight of sample material tested.
8. Note any deviations from test procedure.
9. Name, number of test procedure.
10. Date of test.
11. Test number.
12. Identity of the testing agency of component.

4.6 ELECTRICAL WIRE INSULATION AND ACCESSORY FLAMMABILITY TEST (MOL TEST NO. 5)

4.6.1 Purpose

This test is designed to determine the flammability characteristics of electrical wire insulation and electrical wire accessory materials.

4.6.2 Motion Picture Coverage

Color motion picture coverage with time hacks shall be provided.

4.6.3 Test Equipment

4.6.3.1 Test Chamber

The test chamber shall have sufficient volume to insure complete combustion of the wire bundle specimen and shall be suitably constructed and protected to insure safe operation. A window or viewing port for visual observations and/or photographic documentation purposes shall be provided. The test chamber shall contain inlets for vacuum, source of power for wire overload, air, and oxygen. A horizontal sample holder shall be included and positioned within the test chamber.

4.6.3.2 Pressure Gauge

The pressure gauge shall be capable of measuring pressure from 1 to 1000 ±5 Torr.

4.6.3.3 Oxygen Supply (When Required)

The oxygen shall be commercially available with an analytical content of 95 percent or greater conforming to specification MIL-O-27210, Type 1. Suitable equipment for transferring oxygen to the test chamber shall be provided.

4.6.3.4 Sample Holder

The sample holder shall consist of two horizontally-mounted electrical connections (i.e., knurled bolts) spaced 12 in. apart. The electrical terminals shall be connected to the ignition power source.

4.6.3.5 Ignition Source

An external electrical power supply shall provide sufficient, steady current through one wire of the sample bundle to quickly achieve a very high temperature. The power source shall be capable of supplying a current 10 percent above the nominal fusion current for that gauge wire being tested.

Table 4-1. Nominal Wire Gauge and Fusion Current

Wire Gauge	Nominal Fusion Current (amp)	Initial Current (amp)	Step Current (amp)
28	15	11	2
26	20	15	3
24	30	22	4
22	40	30	5
20	60	45	7
18	80	60	10
16	120	90	15
14	160	120	20
12	225	170	30

4.6.4 Sample Preparation

4.6.4.1 Wire Insulation Samples

a. Insulated wire samples shall be free of cuts, abrasions, or other flaws as determined by close visual inspection. The wires shall be subjected to the Dielectric Withstanding Voltage test in accordance with MIL-STD-202, Method 301, at 1500 volts ac or dc minimum to verify electrical integrity of the sample prior to flammability testing.

b. A test bundle of seven insulated wires (six shall be 12 in. long, one shall be 13 in. long) shall be made up. One end of the bundle shall be twisted 360 deg to result in one full twist over the bundle length. The 13 in. length of wire shall be positioned at the exterior of the bundle and shall be stripped of 1/2 in. of insulation on each end.

4.6.4.2 Electrical Wire Accessories

a. Accessory specimens shall be free of cuts, abrasions, or other flaws as determined by close visual inspection.

b. Accessory specimens shall be installed over or adjacent to wire bundles prepared in accordance with paragraph 4.6.4.1, in the manner in which they are intended to be installed in the Orbiting Vehicle.

4.6.5 Test Procedure

The procedure shall be conducted in the following sequence:

a. The sample wire bundles shall be prepared according to the procedure described in paragraph 4.6.4.1.

b. Electrical wire accessories shall be prepared according to the procedure described in paragraph 4.6.4.2.

c. The sample bundle shall be mounted in the horizontal sample holder and positioned within the test chamber by fastening one end of the stripped wire to each of the binder posts.

d. When oxygen is used, the test chamber shall be evacuated to a pressure of 1 Torr and repressurized to the desired pressure with oxygen. The chamber shall be allowed to stand for one minute. If a change in test chamber pressure is observed after the vacuum pump is closed off from the system, a leak is indicated. The system shall be brought to atmospheric pressure and the leak corrected before any additional tests are carried out. The above procedure should then be repeated.

e. After the test chamber has been stabilized at the desired pressure, the specimens shall be soaked for 30 min. An initial current, 25 percent less than stated for the fusion current for the wire size being tested, shall be applied to the wire (see Table 4-1). If ignition or considerable degradation is not obtained in 1 minute, the current shall be increased by the step current at the end of each minute (i.e., from 30 to 35 and 35 to 40, etc.) until the wire fails or ignition occurs.

f. Three sample bundles of each material shall be tested and the failure of any one material to meet the criteria of paragraph 3.3.9 shall cause rejection of the samples.

4.6.6 Reporting Data

The following test data and pertinent information concerning the materials shall be reported:

a. Name of the material (generic).

b. Vendor designation and vendor.

c. All applicable material and process specifications, and sample preparation details.

d. Usage, quantity, dimensions, and surface area to be used in the Orbiting Vehicle.

e. Results for each test sample.

f. Test environment (atmosphere and pressure).

g. Note any deviations from test procedure.

h. Name and number of test procedure.

i. Date of test.

j. Test number.

k. Identity of the testing agency or component.

l. Name of the test coordinator.

4.7 ELECTRICAL CONNECTOR, POTTING COMPOUNDS, AND COATINGS FLAMMABILITY TEST (MOL TEST NO. 6)

4.7.1 Purpose

This test evaluates the flammability characteristics of electrical connector insert materials, potting compounds, conformal coatings, and similar coverings in the applicable test environment. The test shall simulate a short circuit or dielectric breakdown of current-carrying wires or connector contacts within the potting or coating used to environmentally seal electrical connectors.

4.7.2 Test Equipment

4.7.2.1 Test Chamber

The test chamber volume shall be sufficient to ensure capability of complete combustion of the wire bundle specimen and shall be suitably constructed and protected to ensure safe operation. A window or viewing port for visual observations shall be provided. The test chamber shall contain inlets for vacuum, source of power for wire overload, air, and oxygen. A horizontal sample holder and a central connector mount shall be included and positioned within the test chamber (see Figure 4-1).

4.7.2.2 Pressure Gauge

The pressure gauge shall be capable of measuring pressure from 1 to 1000 ±5 Torr.

4.7.2.3 Oxygen Supply (When Required)

The oxygen shall be commercially available with an analytical content of 95 percent or greater conforming to specification MIL-O-27210, Type 1. Suitable equipment for transferring oxygen to the test chamber shall be provided.

4.7.2.4 Sample Holder and Connector Mount

The sample holder shall consist of two horizontally mounted electrical connectors (bolt with knurled nuts) spaced 12 in. apart. The electrical terminals

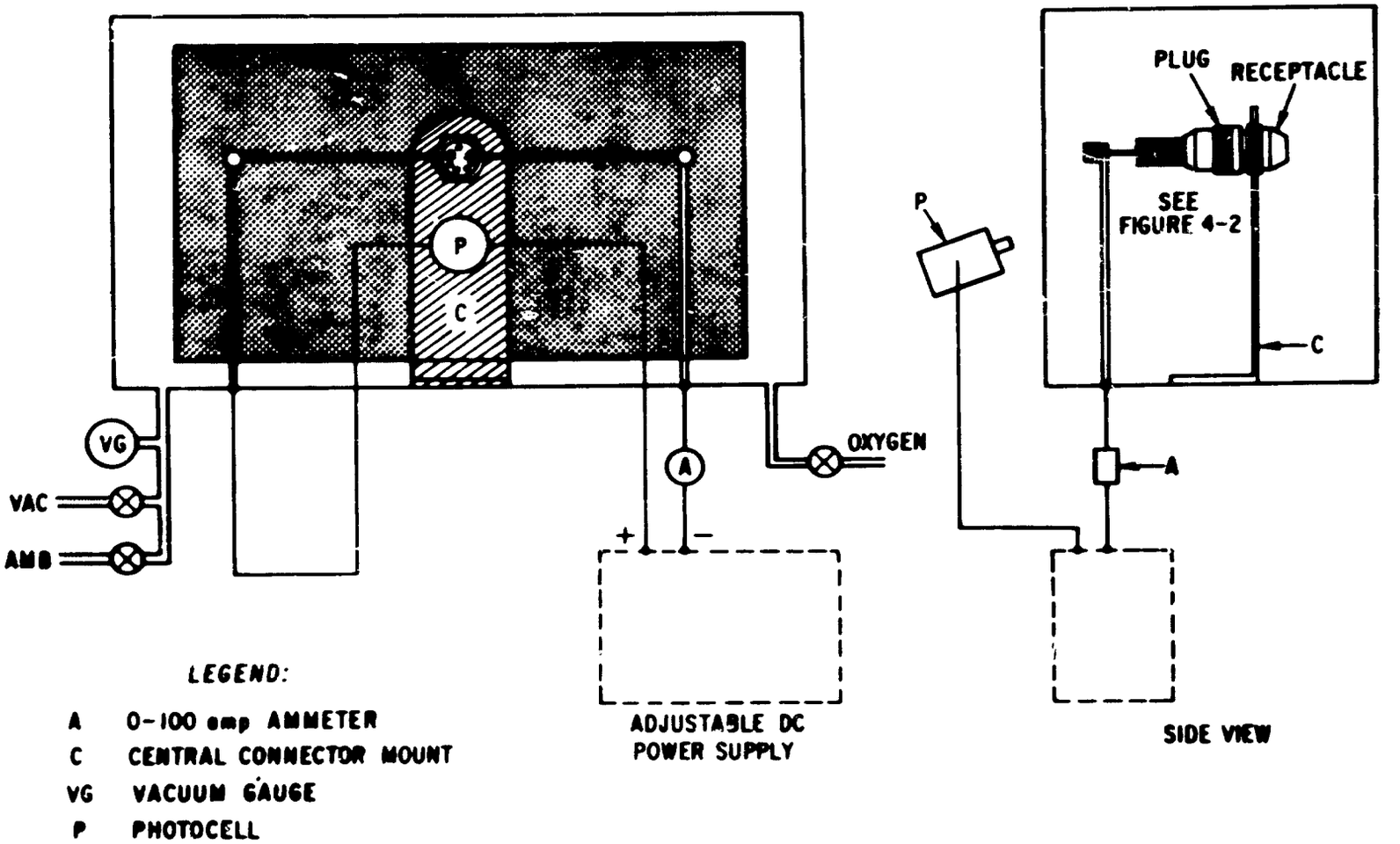

Figure 4-1. Potting Flammability Test Equipment Schematic

shall be connected to the ignition power source. A central connector mount consisting of a vertical panel drilled to receive a horizontal MIL-C-26482 or NAS 1599, or equivalent, jam nut receptacle shall be provided.

4.7.2.5 Ignition Source

An external power supply shall provide sufficient steady current to quickly achieve a very high temperature. The power source must be capable of supplying 100 amp of current through an 18 AWG 14 in. long wire. A photocell to interrupt current at ignition shall be provided.

4.7.3 Sample Preparation

a. Three samples for each candidate potting compound shall be prepared as prescribed in the candidate manufacturer's instructions for preparation.

b. Two 7-in. lengths of AWG 18 insulated wire of the type to be installed in the vehicle electrical harness shall be stripped of 1/2 in. insulation from each end of each piece.

c. Obtain an 11-contact MIL-C-26482 or NAS 1599, or equivalent, straight plug. Crimp one 7 in. wire to contact K and the second 7 in. wire to adjacent contact L (see Figure 4-2).

d. Crimp nine 3-in. long AWG 20 insulated wires in the remaining contacts.

e. The potting boot shall be placed on the connector and filled with the candidate potting compound in accordance with the manufacturer's instructions. The potting compound shall be within recommended shelf life. All steps shall be followed exactly as they would be on flight hardware, including cleaning and priming of connector rear insert for bondability, degassing potting compound, proper humidity control, etc.

f. The compound shall be cured in accordance with the applicable user's procedure or manufacturer's recommended time/temperature for optimum properties.

g. The potting boot shall be removed.

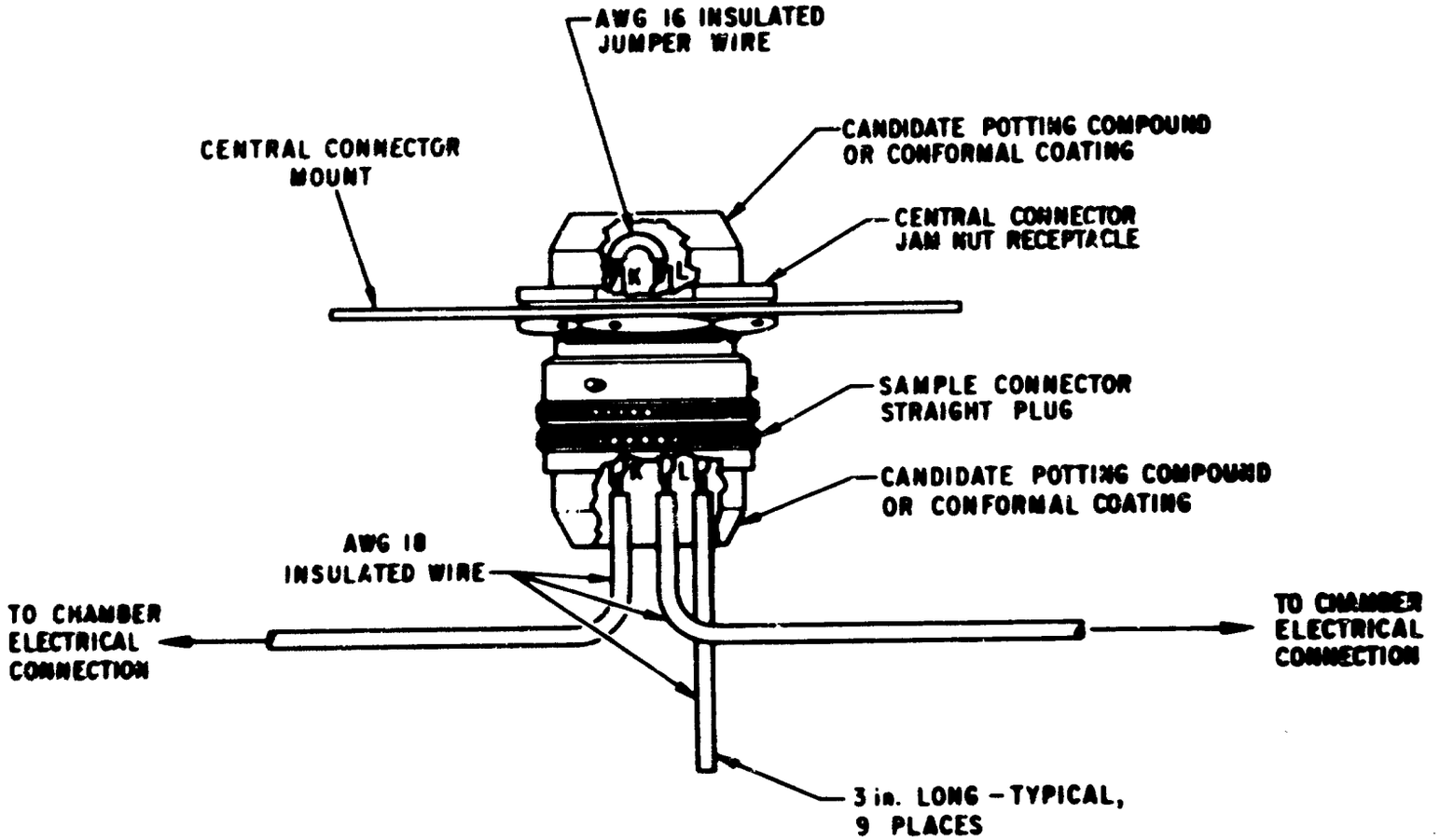

Figure 4-2. Typical Sample Configuration

4.7.4 Central Connector Preparation

a. Three central connectors shall be prepared in accordance with b. through e., below.

b. An 11-contact MIL-C-26482 or NAS 1599, or equivalent (as appropriate), jam nut receptacle shall be obtained to mate to the straight plug. A short AWG 16 insulated jumper shall be crimped between contact K and contact L.

c. The potting boot shall be placed on the connector and filled with the compound to be tested.

d. The compound shall be cured in accordance with the manufacturer's instruction.

e. The potting boot shall be removed.

4.7.5 Test Procedure

The procedure shall be carried out in the following sequences:

a. The sample, prepared in accordance with paragraph 4.7.3 shall be mounted in the horizontal sample holder and positioned within the test chamber by fastening the stripped end of each 7-in. wire to an electrical connection. Mate and lock the specimen electrical connector (straight plug) to the jam nut receptacle (prepared in accordance with paragraph 4.7.4) on the central connector mount.

b. The test chamber shall be evacuated to a pressure of 1 Torr and repressurized to the test pressure with oxygen. The chamber shall be allowed to stand for one minute. A leak is indicated if an increase in test chamber pressure is observed after the vacuum pump is closed off from the system. The system shall be brought to atmospheric pressure and the leak corrected before any additional tests are carried out. The above procedure shall be repeated.

c. After the test chamber has been stabilized at the test pressure, the specimens shall be soaked 10 min. A current of 60 amp shall be applied to the wire. If ignition or considerable degradation is not obtained in one minute, the current shall be increased by 10 amp (i.e., from 60 to 70 and

70 to 80, etc.) until the wire fails or ignition occurs. If ignition occurs prior to wire failing, reduce current to zero amp to evaluate self-extinguishing characteristics of the connector components/potting compound/coating.

4.7.6 Reporting Data

The following test data and pertinent information concerning the materials shall be reported:

a. Name of the material (generic).

b. Vendor designation and vendor.

c. Usage, quantity, and surface area in the spacecraft.

d. Results of each test including combustion phenomena if ignition occurs.

e. Date of test.

f. Test number.

g. Identity of the testing agency or component.

h. Name of the test coordinator.

4.8 ELECTRICAL OVERLOAD TEST (MOL TEST NO. 7)

4.8.1 Purpose

This test is performed to determine if ignition occurs in wiring harness installations due to current overload as a result of faulted wires or connector pins within an elapsed time period of 10 sec.

4.8.2 Test Conditions and Configuration

4.8.2.1 Environment

The test shall be conducted on the test samples in the environment in which each wire bundle will be used in the Orbiting Vehicle.

4.8.2.2 Electrical Harness Accessory Materials

Electrical harness accessories (e.g., wire bundle sleeving, coating materials, bundle ties, heat-shrinkable tubing, potting, connectors, cable clamps, cable-clamp filler materials, identification tags, etc.) shall be identical to those to be installed in the Orbiting Vehicle.

4.8.2.3 Circuit Timer

An elapsed-time meter and switching assembly capable of timing and interrupting the 100 amp ignition source current in 10 ±0.1 sec after activation shall be used.

4.8.3 Test Equipment

4.8.3.1 Test Chamber

The test chamber shall have sufficient volume to insure complete combustion of the wire bundle specimen, should ignition occur. It shall be suitably constructed and protected to insure safe operation. A window or viewing port for visual observations and/or photographic documentation purposes shall be provided.

4.8.3.2 Pressure Gauge

The pressure gauge shall be capable of measuring pressure from 1 to 1000 ±5 Torr.

4.8.3.3 Oxygen Supply

The oxygen supply shall be commercially available oxygen with an analytical content of 95 percent or greater, conforming to specification MIL-O-27210, Type 1. Suitable equipment for transferring oxygen to the chamber shall be provided.

4.8.3.4 Sample Holder

A metallic sample holder shall be provided to mount the connectors and harness clamps.

4.8.3.5 Ignition Source

The external power supply shall provide a heavy current through one pair of wires of the sample bundle to quickly achieve a very high temperature. The power source must be capable of supplying 100 amp current through the test sample under short-circuit conditions.

4.8.4 Sample Preparation

4.8.4.1 Wire

The wire shall be the same type used in the Orbiting Vehicle. All wire sizes and types to be used in the Orbiting Vehicle shall be simulated.

4.8.4.2 Connectors

The same types of connectors shall be used in the test as are to be installed in the Orbiting Vehicle.

4.8.4.3 Electrical Wire Accessories

Wire accessories shall be installed in the same manner on the harness specimen as they will be in the Orbiting Vehicle.

4.8.4.4 Sample Harness

4.8.4.4.1 Wire Lengths

The longest and shortest wire runs to be used in the vehicle shall be simulated.

4.8.4.4.2 Simulated Short-Circuits/Faults

Simulated short circuits shall be applied to the harness by:

a. Clamping two wires (positive and negative) together, after removing 2 in. of the insulation from both wires to provide metal-to-metal contact.

b. Shorting of the output of the connector receptacle pins with the shortest heaviest gauge wire that can be used. Wire of the same type employed in the harness shall be used. Shorts shall be simulated in the harness at nominally 5 ft intervals on all wire sizes. All connectors shall be shorted. Shorts shall be applied one at a time.

4.8.5 Test Procedure

a. The sample bundle shall be prepared according to anticipated use in the Orbiting Vehicle. The wires shall be subjected to a dielectric withstanding voltage test in accordance with MIL-STD-202, Method 301, at 1500 volts ac or dc, minimum, to verify electrical integrity of the sample prior to testing.

b. The sample bundle shall be mounted in the sample holder within the test chamber. Connections shall be made to the external power supply. The power supply and wiring external to the chamber shall be suitably protected with circuit breakers or fuses, but shall be appropriately sized to provide the required test overload current safely.

c. The test chamber shall be evacuated to a pressure of 1 Torr and repressurized to the desired pressure. The chamber shall be allowed to stand for 1 min and then checked for leaks.

d. After the short has been constructed, power shall be applied until the circuit timer outside the chamber trips to interrupt the power. The harness shall be observed through the port during this time, to determine if ignition occurs. The simulated short circuits shall be applied, and powered until interrupt, one at a time.

e. After each portion of the test, the sample shall be inspected for fire damage and repaired, if required, to continue testing.

4.8.6 Reporting Data

The following test data shall be included in a written report to be submitted within 30 days after completion of the test:

a. Vendor designations on all parts and materials.

b. All applicable specifications, sample preparation details, and sample description.

c. Test environment (atmosphere and pressure).

d. Date of test.

e. Results of each test.

f. Photographs of test setup and harness damage.

g. Identity of testing agency.

h. Name of test coordinator.

5.0 NONMETALLIC MATERIALS CONTROL

This section sets forth the minimum requirements for control of nonmetallic materials that shall be met by all MOL contractors. The nonmetallic control requirements delineated herein shall be imposed upon all subcontractors to the degree determined necessary by the contractors. However, assurance and justification shall be provided to the MOL SPO to insure that relaxation of these nonmetallic materials control requirements on the subcontractors will not violate conformance to this specification.

5.1 CONTROL PLAN

The contractor shall prepare a nonmetallic materials control plan. This plan shall, as a minimum, provide methods for implementing the following.

a. Control of material usage according to the categories delineated in paragraph 3.3 and 3.4 to insure that only approved materials are used.

   If deemed necessary to employ a material which is not approved in accordance with paragraph 3.3 and 3.4 the contractor must follow a material waiver procedure described in paragraph 5.3.

b. Control of materials substitutions and deviations.

c. Accounting and definition of all support equipment and materials used to install, modify, check out, and validate elements in the Orbiting Vehicle.

d. Provision for batch control to insure that materials properties have not varied so that flammability and toxicity characteristics will invalidate prior acceptance of the material.

e. Provisions for manufacturing/processing control to insure that materials properties are not varied so that flammability and toxicity characteristics will invalidate prior acceptance of the material.

f. A contaminant control computer program shall be established and continually upgraded to qualify parts and material usage data. Threshold limit values obtained from paragraph 3.4 of this specification and material outgassing rates obtained from outgassing tests or from published data shall be used as inputs to this program. The program shall sum up the outgassing rates of all nonmetallic materials used in pressurized areas for comparison with the capability of the atmospheric contaminants removal systems. If calculated values of atmospheric contaminant materials exceed the values listed in Tables 3-1 and 3-2, the MOL SPO shall be notified.

5.2 NONMETALLIC MATERIALS INFORMATION DESK

The contractor shall establish a Nonmetallic Materials Information Desk. This Desk shall be part of the contractor's internal organization and will also function as part of an integrated network functioning with other MOL contractors. As a minimum, the Nonmetallic Materials Information Desk shall be capable of providing the following information and performing the following tasks.

5.2.1 Reference Library

The Reference Library should provide, as a minimum, ready access to the following:

Computer listing of nonmetallic data microfilm and indexes of nonmetallic materials documents.

Nonmetallic material policies and procedures.

Training films and documents.

Photographs and sketches of nonmetallic materials identification and usage.

Records of material waivers.

5.2.2 Visual Displays

Visual displays shall be maintained for each segment of the Orbiting Vehicle. This display shall show the segment "as built" and the placement of nonmetallic materials.

5.2.3 Coordination

A single point source of contact shall be maintained for request of nonmetallic materials technical information and policies, control of all requests and responses for nonmetallic materials information, and for communication with other Nonmetallic Materials Information Desks.

5.3 NONMETALLIC MATERIALS REVIEW BOARD

The contractor shall establish within his MOL organization a nonmetallic material review board. The function of this board shall be the review and approval or rejection of the use of any nonmetallic material in his segment of the Orbiting Vehicle which does not meet the requirements set forth in paragraph 3.3 of this specification. As a minimum, data submitted to this board shall delineate the following:

Material identification
Manufacturer
Intended use
Appropriate specifications
Where to be used
When to be used
Surface area exposed to environment
Applicable test data
Atmosphere and maximum atmospheric pressure
Maximum surface temperature
Reason for request of deviation
Justification for intended use relative to design adequacy
Analysis of alternate material considerations

This Board shall consist of a chairman and at least three members. Disciplines represented shall include materials engineering, crew systems, safety and reliability engineering. One board member shall be designated as alternate chairman. Each board member shall have a designated alternate. The contractor shall prepare and submit to the MOL SPO the method of the boards operation. The findings and determination of this board shall be reported to the MOL SPO.

APPENDIX A

ESTABLISHMENT OF MOL THRESHOLD LIMIT VALUES (TLVs) FOR ATMOSPHERIC CONTAMINANTS

The MOL TLVs in milligrams per cubic meter of free air space which are listed in Table 3-1 have been established by three general methods. The MOL TLVs for specific contaminants identified in nuclear submarines were established by extrapolating the nuclear submarine TLV for 90-day continuous exposure to the MOL mission continuous-exposure time period. This extrapolation was accomplished through a log-log plot of industrial TLV and nuclear submarine TLV versus exposure time. The MOL TLV represents the intercept point of the concentration line and the MOL mission timeline.

The second method involved the assignment of MOL TLVs to contaminants which have not been assigned nuclear submarine TLVs for 90-day continuous exposure. A log-log plot of industrial TLVs versus nuclear submarine 90-day continuous exposure TLVs resulted in a straight line correlation for 90-day continuous exposure TLVs in the concentration range of 0.001-10,000 mg/m^3 and for industrial TLVs in the concentration range of 0.004-10,000 mg/m^3. This concentration line was used to assign 90-day continuous exposure TLVs to contaminants with established industrial TLVs.

The third method involved contaminants with unestablished industrial TLVs. A chemical compound with comparable chemical composition and toxic properties and an established industrial TLV was used as the reference compound. The MOL TLVs were established as in the second method through utilization of the reference industrial TLV.

In the case of certain specific contaminants, the MOL TLV derived from the general extrapolation methods discussed in the above paragraph were adjusted either upward or downward, depending on the available toxicological data. This principle will be utilized in future updating of MOL TLVs.

The MOL TLVs represent the concentration versus inhalation exposure time relationship for an individual contaminant to prevent an acute toxic response that would adversely affect crew mission performance.

APPENDIX B

DEFINITIONS

The following definitions of terms used herein form a part of this specification. In the event of conflict between definitions cited herein and definitions in other documents, the MOL SPO shall be informed of such discrepancies. The MOL SPO will then define the superseding definition.

Pressure Suit Assembly (PSA)	The PSA shall consist of: (1) all garments required to protect the crewman from the environments anticipated during emergency and normal operations; and (2) all systems and components required to store waste in the suited mode, and to support the crewman for short periods as a self-contained unit.
High-Pressure Oxygen	High-pressure oxygen is defined as oxygen at pressure greater than 19 psia.
Combustion rate	"Combustion rate" and "flame propagation rate" are used interchangeably and are defined as the rate at which the flame front propagates along the specimen, expressed in inches per second.
Flash Point	The temperature of the specimen surface at which a non-self-sustaining flash or flame occurs near the visible surface immediately on sparking.
Fire Point	The temperature at which a self-sustaining flash or flame occurs at or near the sample surface.
Outgassing (Offgassing)	Outgassing is the evolution of gaseous product(s) when a liquid or solid material is exposed to an environment. (The temperature and pressure of the environment directly affect the rate of outgassing for a given material application.)

Odor Rating	Odor rating is a systematic means of classifying basic odors. (The odor test used to obtain the odor rating is delineated in paragraph 4.4.)
Total Organics	Total organics is a measure of the concentration of gaseous organic compounds, referenced to a saturated hydrocarbon (e.g., methane).
Self-Extinguishing	A material shall be considered self-extinguishing if it does not support combustion upon removal of the ignition source. If there is any sustained propagation of the flame front prior to extinguishment or burning for a period in excess of 2 sec, the material shall not be considered as self-extinguishing.
Melting Point	Melting point is that temperature at which a solid starts to soften and is about to change from a solid state to a molten state.
Threshold Limit Value (TLV)	TLV expressed in milligrams per cubic meter represent the allowable concentration of a potential toxic component in the atmosphere.
Asphyxiant Gas	A gas which produces a deficiency of oxygen and excess of carbon dioxide in the blood stream.
Explosive Gas	A gas which is capable of undergoing an exothermic chemical reaction in which relatively large amounts of other gases are produced. These product gases are considered as atmospheric contaminants rather than toxicants or asphyxiants.